**3.1 – Introduction to Chemical Reactions**

Chemical reactions are processes in which a set of substances called reactants is converted to a new set of substances called products

Simply put, a chemical reaction is the process by which a chemical change occurs.

**When does a chemical change take place?**

These are the most common indicators that a chemical reaction or change has taken place:

* A colour change
* Formation of a solid (called a precipitate)
* Formation of a gas
* Release or absorption of heat

Bottom line here: **When a chemical reaction or change occurs, a new substance (or substances) is always formed.**

(DEMOS)

* Let’s take a look at an equation. We will use the baking soda/vinegar example from the demo:

NaHCO3 + CH3COOH 🡪 NaCH3COO + H2O + CO2

**REACTANTS** 🡪 **PRODUCTS**

This is a chemical equation. Typically, the reactants appear on the left, and are connected by drawing an arrow to the products on the right.

**Writing Chemical Equations**

Sometimes, we will need to write an equation when only given words to describe an equation. Let‘s try an example:

* A solution of sodium iodide is added to a solution of potassium nitrate to make a potassium iodide precipitate and a sodium nitrate solution.

First, identify products and reactants, and write it in words:

Sodium iodide + potassium nitrate 🡪 potassium iodide + sodium nitrate

Next, put it into formulas:

NaI + KNO3 🡪 KI + NaNO3

**Identify States**

One other thing we can add to the previous equation is the state of each reactant and product. This is done with a subscript.

* Solution, or dissolved = (aq, means aqueous)
* Gas = (g)
* Precipitate or solid = (s)
* Liquid = (l). Usually this is what water is, unless it is specified as a gas.

Then, our previous equation would look like this:

NaI(aq) + KNO3(aq) 🡪 KI(s) + NaNO3(aq)

**Types of Reactions**

There are 6 common types of chemical reactions that we will consider:

1. Combustion

2. Synthesis

3. Decomposition

4. Single Displacement

5. Double Displacement

6. Acid-base

1. **A combustion reaction** is when oxygen combines with another compound to form water and carbon dioxide. These reactions are exothermic, meaning they produce heat.

Example: burning propane in your BBQ

C3H8 + 5O2 🡪 3CO2 + 4H2O

1. **A synthesis reaction** is when two or more simple compounds combine to form a more complicated one. These reactions come in the general form of:

**A + B** 🡪 **AB**

One example of a synthesis reaction is the combination of iron and sulfur to form iron (II) sulfide:

8Fe + S8 🡪 8FeS

1. **A decomposition reaction** is the opposite of a synthesis reaction - a complex molecule breaks down to make simpler ones. These reactions come in the general form:

**AB** 🡪 **A + B**

One example of a decomposition reaction is the electrolysis of water to make oxygen and hydrogen gas:

2H2O 🡪 2H2 + O2

1. **A single displacement reaction** is when one element trades places with another element in a compound. These reactions come in the general form of:

**A + BC** 🡪 **AC + B**

One example of a single displacement reaction is when magnesium replaces hydrogen in water to make magnesium hydroxide and hydrogen gas:

Mg + 2H2O 🡪 Mg(OH)2 + H2

1. **A double displacement reaction** is when the anions and cations of two different molecules switch places, forming two entirely different compounds. These reactions are in the general form:

**AB + CD** 🡪 **AD + CB**

One example of a double displacement reaction is the reaction of lead (II) nitrate with potassium iodide to form lead (II) iodide and potassium nitrate:

**Pb(NO3)2 + 2KI** 🡪 **PbI2 + 2KNO3**

1. **An acid-base reaction** is a special kind of double displacement reaction that takes place when an acid and base react with each other. The H+ ion in the acid reacts with the OH- ion in the base, causing the formation of water. Generally, the product of this reaction is some ionic salt and water:

**HA + BOH** 🡪 **H2O + BA**

One example of an acid-base reaction is the reaction of hydrobromic acid (HBr) with sodium hydroxide: **HBr + NaOH** 🡪 **NaBr + H2O**

**Tips for determining the type of reaction taking place**

Follow this series of questions. When you can answer "yes" to a question, then stop!

1)  Does your reaction have oxygen as one of it's reactants and carbon dioxide and water as products? If yes, then it's a combustion reaction

2)  Does your reaction have two (or more) chemicals combining to form one chemical? If yes, then it's a synthesis reaction

3)  Does your reaction have one large molecule falling apart to make several small ones? If yes, then it's a decomposition reaction

4)  Does your reaction have any molecules that contain only one element? If yes, then it's a single displacement reaction

5)  Does your reaction have water as one of the products? If yes, then it's an acid-base reaction

6)  If you haven't answered "yes" to any of the questions above, then you've got a double displacement reaction